The Safety Corner

From the Marine Corps Center for Lessons Learned
December 21, 2007

Compressed Gas Cylinders

This issue of the Safety Corner highlights safety tips on proper handling of compressed gas cylinders and equipment.

In this Issue:

From the Director: Compressed gas cylinders are used in many maintenance shops and aboard ships to store gases that vary from extremely flammable to inert. When handled properly, compressed gas cylinders are safe, but when handled improperly, even cylinders with inert gas can present a severe hazard to Marines and Sailors.

For Marines and Sailors who work with compressed gas and gas handling equipment, safety is paramount; ignorance of safety procedures is no excuse for noncompliance. Gas cylinders expose Marines and Sailors to both chemical and physical hazards and have the potential to cause lasting damage to people, equipment, and the environment.

Gases contained within compressed gas cylinders can be toxic, flammable, oxidizing, corrosive, inert, or a combination thereof. Marines and Sailors who handle compressed gas cylinders or equipment must be familiar with the most common causes of ruptures, such as over-pressurization, regulator failure, mechanical stress, and corrosion.

Proper training is vital; remember, the greatest physical hazard represented by the compressed gas cylinder is the tremendous force that may be released if knocked over. If the neck on a pressurized cylinder is accidentally broken off, the energy released may be sufficient to propel the cylinder over three-quarters of a mile and attain speeds of over 30 miles an hour. You have a duty to protect your fellow Marines and Sailors from occupational hazards and to ensure safety procedures are followed.

You are welcome to pass on and post this newsletter for widest dissemination. Log on the www.mccll.usmc.mil to download previous editions of the Marine Corps Center for Lessons Learned Safety Corner as well as our Monthly Newsletters. I look forward to receiving your comments and feedback so we can raise awareness, reduce risk and maintain a high level of readiness.

Semper Fidelis,
Col Monte Dunard, Director MCCLL
Email : monte.dunard@usmc.mil. Telephone: 703.432.1286 DSN: 378.1286

Types of Hazards Associated with Compressed Gas Cylinders

1. **Chemical hazard associated with the cylinder contents (corrosive, toxic, flammable, etc.)**
2. **Physical hazards represented by the presence of a high pressure vessel.**

Click here to view Regulations (Standards - 29 CFR)
http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=0

21 Safe Practices When Working With Compressed Gases

1. Read the Material Safety Data Sheets and labels for all of the materials you work with.
2. Know all of the hazards (fire/explosion, health, chemical reactivity, corrosives, pressure) of the materials you work with.
3. Know which of the materials you work with are compressed gases and check the label, not the cylinder color, to identify the gas.
4. Store compressed gas cylinders in cool, dry, well-ventilated areas, away from incompatible materials and ignition sources.
5. Ensure that the storage temperature does not exceed 52°C (125°F).
6. Store, handle and use compressed gas cylinders securely fastened in place in the upright position. Never roll, drag, or drop cylinders or permit them to strike each other.
7. Move cylinders in handcarts or other devices designed for moving cylinders.
8. Leave the cylinder valve protection cap in place until the cylinder is secured and ready for use.
9. Discharge compressed gases safely using devices, such as pressure regulators, approved for the particular gas.
10. Never force connections or use homemade adaptors.

(continued)

The Safety Corner

From the Marine Corps Center for Lessons Learned

December 21, 2007

21 Safe Practices When Working With Compressed Gases (continued)

11. Ensure that equipment is compatible with cylinder pressure and contents.
12. Carefully check all cylinder equipment connections before use and periodically during use, to be sure they are tight, clean, in good condition and not leaking.
13. Carefully open all valves, slowly, pointed away from you and others, using the proper tools.
14. Close all valves when cylinders are not in use.
15. Never tamper with safety devices in cylinders, valves or equipment.
16. Do not allow flames to contact cylinders and do not strike an electric arc on cylinders.
17. Always use cylinders in cool well-ventilated areas.
18. Handle "empty" cylinders safely, leave a slight positive pressure in them, close cylinder valves, disassemble equipment properly, replace cylinder valve protection caps, mark cylinders "empty" or "MT," and store them separately from full cylinders.
19. Wear the proper personal protective equipment.
20. Know how to handle emergencies such as fires, leaks or personal injury.
21. Follow the health and safety rules that apply.

Compressed Gas Cylinder Inspections

Gas cylinders should be visually inspected to ensure that they are in a safe condition. If necessary, a cylinder can be tested ultrasonically for hidden defects. Leaking regulators, cylinder valves or other equipment should be taken out of service. A cylinder's contents should be identified at all times. Cylinder status should also be identified; for example, whether the cylinder is full, empty or in service.

Storing Compressed Gas Cylinders

Store compressed gas cylinders in compliance with the occupational health and safety regulations and fire and building codes. Gas cylinders should be properly secured at all times to prevent tipping, falling or rolling. They can be secured with straps or chains connected to a wall bracket or other fixed surface, or by use of a cylinder stand. Store cylinders in a cool, dry, well-ventilated, fire-resistant area that is accordance with federal, state and local regulations. A cylinder storage area should be located in an area where the cylinders will not be knocked over or damaged by falling objects. When a cylinder is not being used, the valve should be closed and the valve protector secured in place.

Transporting/Moving Compressed Gas Cylinders

Always transport cylinders with valve caps or other valve protection in place. Pulling cylinders by their valve caps, rolling them on their sides or dragging or sliding them can cause damage. Rolling cylinders on their bottom edge ("milk churning") may be acceptable for short distances. Appropriate lifting devices, such as cradles or nets, must be used when employing a crane, hoist or derrick to transport gas cylinders.

Never lift cylinders with magnets or chain or wire rope slings. Transport cylinders on specially built hand carts or trolleys or other devices designed for this. All transport devices should have some way of securing cylinders to prevent them from falling. Be sure to close all cylinder valves when not in use. The valves of empty cylinders should also be closed. Ensure that gas cylinders are transported so that they do not tip, fall or roll. Regulators should be removed; do not tamper with or attempt to repair a gas cylinder regulator. It is also important to select the proper regulator for use with each gas cylinder. A lubricant should not be used on a gas cylinder regulator. Valve protections caps should be secured in place before moving cylinders. Also, cylinder valves should be closed before moving cylinders.

It is necessary to take precautions so that gas cylinders are not dropped or allowed to strike each other or other objects. Dropping or striking may damage the cylinder valve, which could turn the cylinder into a dangerous torpedo with the potential to destroy property and/or injure personnel. Consult the appropriate material safety data sheets (MSDS) for detailed information on the chemical contained in the gas cylinder. Specific chemical handling and storage precautions will be outlined in the MSDS.

The Safety Corner

From the Marine Corps Center for Lessons Learned

December 21, 2007

Gas Categories

Corrosive - Gases that corrode material or tissue with which they come in contact, or do so in the presence of water, are classified as corrosive. They can also be reactive and toxic and/or flammable or an oxidizer.
Flammable - Gases that, when mixed with air at atmospheric temperature and pressure, form a flammable mixture at 13% or less by volume, or have a flammable range in air of greater than 12% by volume regardless of the lower flammable limit, are classified as flammable. They can be high-pressure, toxic, and reactive and displace oxygen in air. A change in temperature, pressure or oxidant concentration may vary the flammability range considerably.
Inert - Gases that do not react with other materials at ordinary temperature and pressure are classified as inert. They are colorless and odorless, as well as nonflammable and nontoxic. The primary hazard of these gases is pressure. These gases are often stored at pressures exceeding 2,000 psi. Also, they can displace the amount of oxygen necessary to support life when released in a confined place. Use of adequate ventilation and monitoring of the oxygen content in confined places will minimize the danger of asphyxiation.
Oxidizer - Gases that do not burn, but will support combustion, are classified as oxidants. They can be high-pressure, toxic and reactive, and can displace breathing oxygen from the air.
Toxic - Gases that may produce lethal or other harmful effects on humans are classified as toxic. They can be high pressure, reactive, nonflammable or flammable, and/or oxidizing in addition to their toxicity. The degree of toxicity and the effects will vary depending on the gas.

The Sleeping Giant

I am a high pressure, compressed gas cylinder. I stand 57 inches tall.
I am 9 inches in diameter.
I weigh in at 155 pounds when filled.
I am pressurized at 2,200 pounds per square inch (psi).
I have a wall thickness of about 1/4 inch.
I wear a regulator and hose when at work.
I wear a label to identify the gas I am holding. My color is not the answer.
I transform glistening ships and many other things into miscellaneous stacks of material when allowed to unleash my fury unchecked.
I can be ruthless and deadly in the hands of the careless and uninformed.
I am too frequently left standing alone on my small base without other visible means of support; my cap removed by an unthinking worker.
I am ready to be toppled over, where my naked valve can be damaged or even snapped off and all my power unleashed through an opening no larger than a lead pencil.

I am still proud of my capabilities, here are a few of them:

I have on rare occasions been known to jet away - faster than any dragster.
I might smash my way through brick walls.
I might even fly through the air.
I may spin, ricochet, crash and slash through anything in my path.

Take the following steps to prevent a disaster:

Full or empty - see to it that my cap is on, straight and snug.
Never leave me standing alone. Secure me so that I cannot fall.

To down load the Sleeping Giant poster click here: http://www.cganet.com/pubs/free/SP-F_1.pdf

In Case of an Emergency

- Act fast in emergencies such as chemical fires or gas cylinder leaks.
- Evacuate the area at once if you are not trained to handle the problem or if it is clearly beyond your contro
- Alert other people in the area to the emergency.
- Call the fire department immediately.
- Report the problem to the people responsible for handling emergencies.
- Obtain first aid and remove all contaminated clothes if you have been exposed to harmful chemicals.

(Continued)

The Safety Corner

From the Marine Corps Center for Lessons Learned

December 21, 2007

In Case of an Emergency (continued)

➢Locate emergency eyewash stations and safety showers whenever accidental exposure is possible to gases that can cause damage skin or eyes.
➢Only specially trained and properly equipped people should handle emergencies. Nobody else should go near the area until it is safe.
➢Plan, train and practice for emergencies.
(Note: All major compressed gas suppliers have emergency response teams. These teams can be activated by calling the telephone number that is usually printed on the shipping documents and MSDSs).

If you supervise a maintenance shop that uses compressed gas cylinders:

1. Do you have a procurement and inventory tracking system set up to help minimize the size and quantity of pressurized-gas cylinders?
2. Do you have written procedures on the safe handling and proper storage of pressurized cylinders?
3. Have Marines and Sailors who handle compressed-gas cylinders been properly trained?
4. Are Marines and Sailors trained to handle worst-case scenarios from hazardous compressed gas releases?
5. Are **ALL** cylinders properly identified or labeled?
6. Do **ALL** cylinders have the hydrostatic test label as required by Department of Transportation specifications?
7. Do procedures address the situation in which non-empty cylinders must be disposed of rather than returned?

If you work with compressed gas cylinders:

1. **Do you** have the required personal protective equipment?
2. **Do you** know the proper ways of securing compressed-gas cylinders?
3. **Do you** know the procedures for safely moving these cylinders?
4. **Do you** know what to do with a leaking cylinder?
5. **Do you** have a checklist for safe cylinder handling and storage?
6. Are eyewash fountains and emergency showers nearby and working?
7. Are dry chemical fire extinguishers available?
8. Are there special requirements for handling particular pressurized cylinders?
9. Are special ventilated cabinets needed for highly toxic gases?

Test your Knowledge (answers on bottom of next page)

1. **If the regulator to an oxygen cylinder is difficult to thread, you should:**
a. Oil the threads
b. Return the cylinder or regulator to supplier
c. Use a crescent wrench to tighten it
d. Use a regulator from a nitrogen cylinder

2. **Cylinders may safely be secured by:**
a. Duct tape
b. Bracing the cylinder on two sides by non-movable objects such as a refrigerator and storage bench
c. Chains
d. All of the above

3. **Cylinders containing flammable gases shall not be stored near**:
a. Areas where electrical sparks might be generated
b. Bunsen burners
c. Pilot lights
d. All of the above

4. **Oxygen cylinder valves should be opened all the way**.
True False

5. **Cylinders should never be rolled or dragged.**
True False

The Safety Corner

From the Marine Corps Center for Lessons Learned

December 21, 2007

Regulators are gas specific, and not necessarily interchangeable!

Always make sure that the regulator and valve fittings are compatible.

Types of Gases

(C2H2) Acetylene: A colorless extremely flammable gas with a detectable garlic like odor. In its free state, acetylene may violently decompose if the pressure of the gas exceeds 15 psig. Acetylene is shipped and stored dissolved in acetone.

(He) Helium: A colorless, odorless, non-reactive inert gas which is compressed to high pressures. It acts as a simple asphyxiant by displacing air.

(C3H8) Propane: At room temperature and atmospheric pressure, propane is a colorless, flammable, nontoxic gas, with a characteristic natural gas odor. Propane is one of the group of liquefied petroleum gases. It is normally shipped in low pressure cylinders as a liquefied compressed gas under its own vapor pressure of 752 kPa (109 psig) at 21.1 degrees C.

Compressed Air: A colorless, odorless synthetic gas compressed to high pressure which can greatly accelerate ordinary oxidations at high pressure.

(O2) Oxygen: A colorless, odorless, tasteless elemental gas that supports life and combustion, constitutes about a fifth of the atmosphere. At temperatures ranging below -300 degrees F, it is a transparent, pale blue liquid that is slightly heavier than water. All elements except the inert gases combine directly with oxygen to form oxides. Oxygen is non flammable but it readily supports combustion. All materials that are flammable in air burn much more vigorously in oxygen. Some combustibles, such as oil and grease, burn with nearly explosive violence in oxygen if ignited.

(H2) Hydrogen: A colorless, odorless, flammable gas which is compressed to high pressure. High pressure leaks frequently ignite spontaneously and burn with a colorless flame.

(N2) Nitrogen: At room temperature and atmospheric pressure, nitrogen is a colorless, odorless, nontoxic, nonflammable gas. It constitutes 78% by volume of the atmosphere. Naturally occurring nitrogen contains two isotopes, 14N and 15N, with a relative abundance of 99.62% and 0.38%, respectively.

(NH3) Anhydrous Ammonia: A colorless , flammable, toxic, alkaline gas shipped as a liquefied gas at its vapor pressure of 116.7 psig at 70°F (21°C). It causes burns on contact with eyes, skin, and mucous membranes.

(Ar) Argon: A colorless, odorless, nonreactive, inert gas which is compressed to high pressures. It acts as a simple asphyxiant by displacing air. Argon belongs to the family of inert rare gases of the atmosphere. It is extremely inert and forms no known chemical compounds.

(C3H4) MAPP Gas: A colorless, non-toxic flammable gas with a very distinctive natural odor. Shipped as a liquid at it's vapor pressure of 97 psi at 70°F.

(CO2) Carbon Dioxide: A colorless, liquefied, high-pressure gas which is slightly acidic and is shipped at its vapor pressure of 830 psi at 70°F. It is relatively nonreactive and nontoxic. It will not burn, and it will not support combustion or life. Solid carbon dioxide ("dry ice") at atmospheric pressure transforms directly to a gas without passing through the liquid phase.

*Gas Mixtures refer to compressed gases that have been combined or blended into a single container.

Answers to quiz: b, c, d, T, T

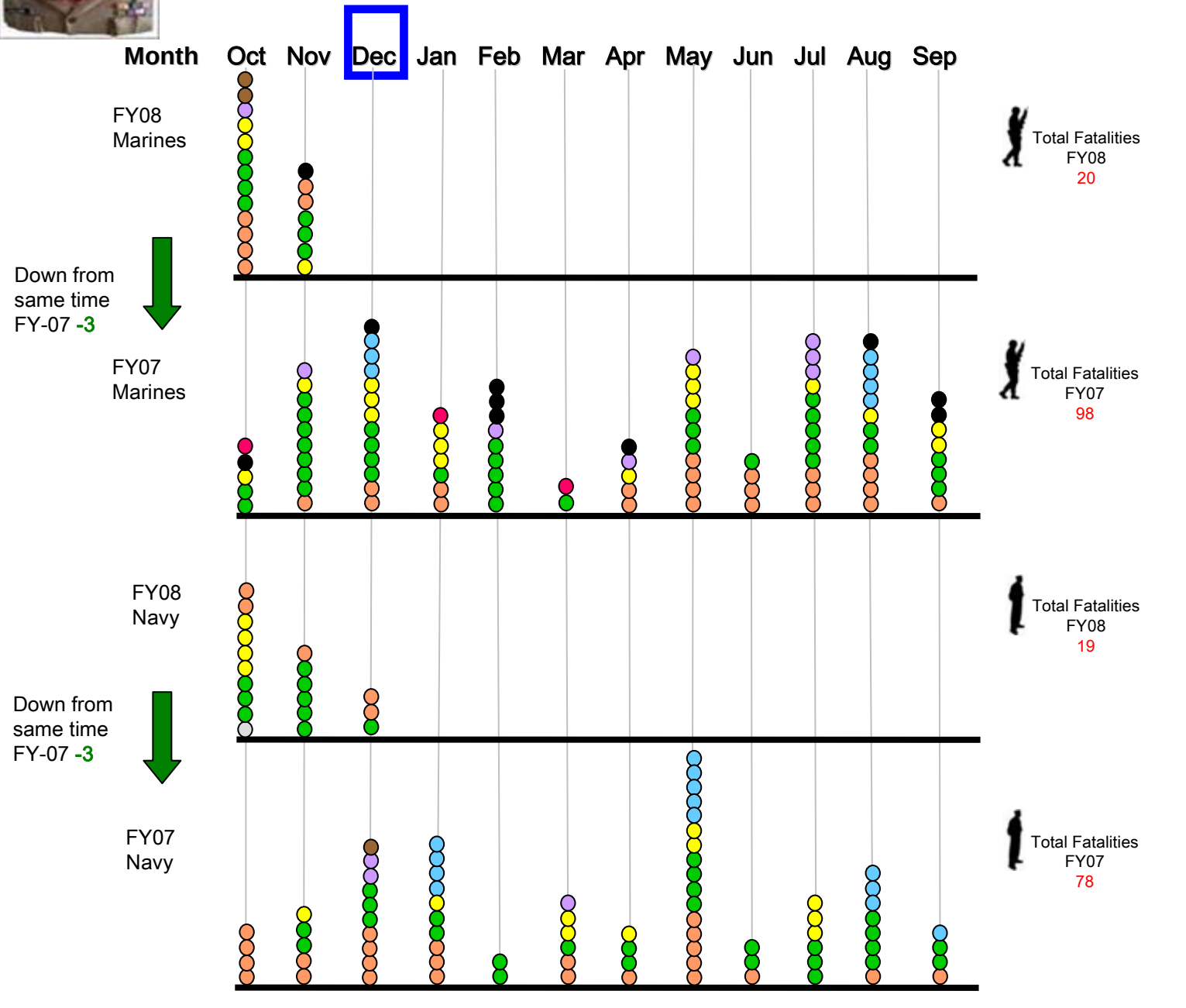
The Safety Corner

From the Marine Corps Center for Lessons Learned

December 21, 2007

Carelessness doesn't bounce; it shatters.
Hartman Jule

Fatality Summary as of 28 Nov 07



The Safety Corner

From the Marine Corps Center for Lessons Learned

December 21, 2007

"Where there is no leadership the people fall, but in an abundance of counselors there is safety"
. Sword

If the regulator to an oxygen cylinder is difficult to thread, you should:
Oil the threads
XReturn the cylinder or regulator to supplier
Use a crescent wrench to tighten it
Use a regulator from a nitrogen cylinder

If you find a compressed gas cylinder without a label, you should:
Make your best guess as to what the gas is, based on cylinder color
Attach a regulator and test the gas
xMark the contents "unknown" and return immediately to the supplier
Segregate in a storage closet until identification can be made safely

It is safe to conduct minor repairs on the valves of cylinders containing "harmless" gases.
True
xFalse

Cylinders may safely be secured by:
Duct tape
Bracing the cylinder on two sides by non-movable objects such as a refrigerator and storage bench
x Chains
All of the above

When equipment is left unattended or not operating, cylinder valves should always be:
xClosed
Left open

Oxygen cylinder valves should be opened all the way.
xTrue
False

Which type of cylinder should never be stored on its side?
xAcetylene
Helium
Self-Contained Breathing Apparatus
Oxygen

Cylinders containing flammable gases shall not be stored near:
Areas where electrical sparks might be generated
Bunsen burners
Pilot lights
xAll of the above

It is acceptable to use plastic piping for parts of a high pressure system.
True
x False

Cylinders should never be rolled or dragged
True
False